FREEDM, Circuits and Electronics Practice Problems in Electrical Engineering

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FREEEDM

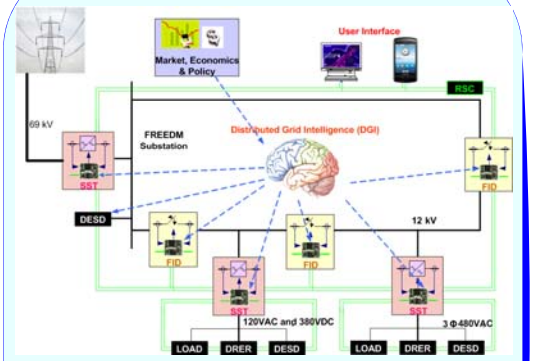
The **Future Renewable Electric Energy Delivery and Management** (FREEDM) Systems Center is an NSF-ERC established in 2009 that envisions a revolutionary power grid with focus on energy generation, distribution, and storage.

Educational objectives

The FREEDM Systems Center College Education Program was designed to educate a new generation of engineers and scientists to renewable energy based electric power systems. Creating a pipeline of future leaders and innovators through the development of new academic courses and degree programs at both undergraduate and graduate levels remains a key FREEDM Systems Center goal.

The Center Pre-college Education program develops this pipeline notion through work with middle and high school teachers and students.

Activities and opportunities



The FREEDM Systems Center has many opportunities for undergraduate and graduate education in the fields of renewable energy system, power electronics, distributed control, power systems, power semiconductor devices and power management IC.

1) Graduate Portfolio Program

2) Graduate and undergraduate certificates/concentration programs

Execution

Partner Universities:

1) North Carolina State University
2) Arizona State University
3) Florida State University
4) Florida Agricultural and Mechanical University
5) Missouri Science and Technology University

Each partner university offers at least one **certificate or concentration program** in the renewable energy or a similar area to help students prepare fro their career.

The Center has developed **partnerships with a number of middle-and-high schools** in 4 states to increase awareness of the importance of renewable energy systems and recruit future students. A feature of our Center is the theme "each one mentor one." A network of interconnections is being created between industry members, faculty, graduate students, undergraduate students, teachers, and high school students.

Circuits and Electronics problems

Educational Objectives

1) Create an user friendly and interactive software (**RandFlux©**) that is able to generate automatically practice problems in the areas of circuits and electronics, solve them and post the analytical solution on a webpage or in a Word document

2) Use this software in teaching undergraduate courses in circuits and electronics

Potential

This software has the potential to replace regular textbook problems. In the future, one should be able to access it online or on mobile devices so that any student could practice and improve their knowledge in circuits and electronics.

More about RandFlux©

The software can also be used by graduate students to perform physics-based (finite-element) simulations of semiconductor devices, energy storage devices (e.g. batteries, fuel cells, etc.), and power grids.

RandFlux© uses **HysterSoft©** to define hysteretic materials.

Learning materials and execution

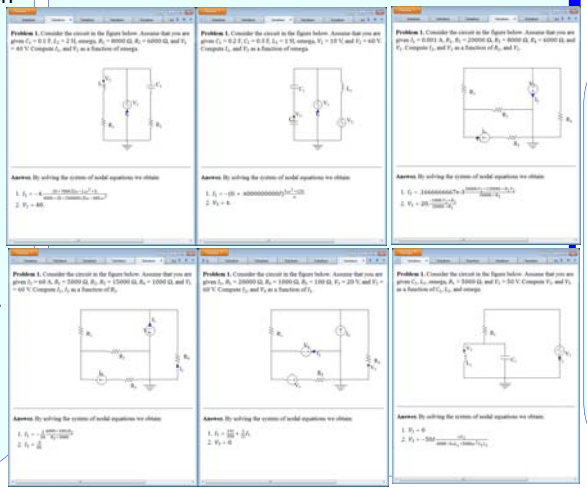
RandFlux© can solve most problems from microelectronics textbooks analytically. Students should:

1. draw the circuit using the Circuit Editor
2. provide the data that is given in the problem
3. specify what needs to be computed analytically or numerically
4. run the simulation (answers are printed on a web page or in a MS Word file).

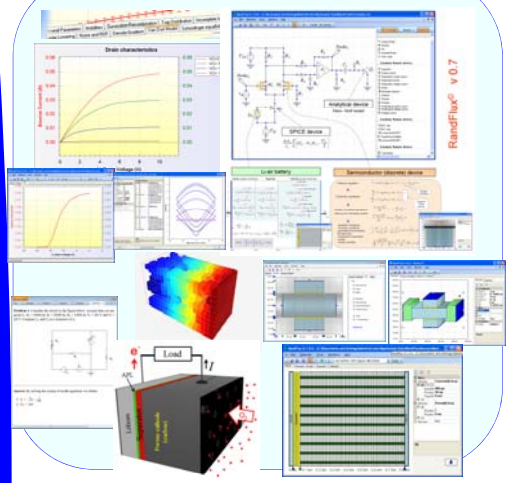
RandFlux© can also:

- Create new practice problems
- Solve problems symbolically
- Create un "unlimited" number of practice problems in circuits and electronics with just one click
- Be used in teaching *Electronics, Semiconductor Theory,* and *Solid-State Electronics* courses

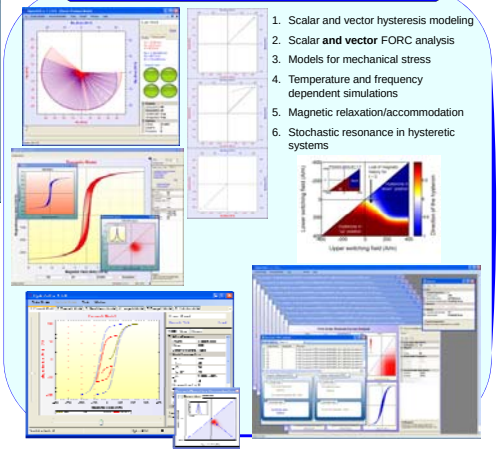
The problems below are all generated and solved automatically



RandFlux©-circuit simulator



HysterSoft©-hysteretic materials



1. Scalar and vector hysteresis modeling
2. Scalar **and vector** FORC analysis
3. Models for mechanical stress
4. Temperature and frequency dependent simulations
5. Magnetic relaxation/accommodation
6. Stochastic resonance in hysteretic systems